CASE #PL2021-208

HERZOG
ENGINEERING LLC

Design 1
Attention: Sam Diedrich
9973 Valley View Road
Eden Prairie, MN 55344

March 25, 2021

Re: Structural Analysis
MIN Airport L-Sub 6
CPC059-STRL1 Structural - Building/Rooftop Attachment
7900 International Drive
Bloomington, MN 55425
Project Number: 211095

Dear Mr. Diedrich:

At your request, I have analyzed the structural capacity of the existing antenna support framing and the existing roof screen to support the proposed equipment changes on the antenna support frame. The proposed equipment to be supported on the existing antenna support frame is shown in Table 1 of this report.

In summary, the existing antenna support frame and roof screen have been analyzed and have been found to have **SUFFICIENT CAPACITY** to support the proposed equipment. The design stress ratios with regards to maximum design capacity are shown in Table 2.

Per TIA-222-H, all bolted connections, including u-bolts, shall be provided with nut-locking device or mechanism such as, but not limited to, lock nuts, lock washers, or palnuts, to prevent loosening.

This structural analysis has been performed in accordance with the local code requirements listed in this report and the disclaimers noted within.

If you have any questions, please don't hesitate to contact me at (612) 844-1234.

Sincerely,
**Herzog Engineering, LLC**

JT Kowalchuk, P.E.
Structural Engineer

Thomas L. Mach, P.E.
Structural Engineer

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Print Name: Thomas L. Mach

Signature

Date 03/25/2021 License #

## A. SCOPE OF WORK SUMMARY

The intent of this structural analysis is to complete a feasibility structural analysis per the TIA-222-H standard, Section 16.9 for the supporting structure with the proposed equipment loading.

## B. BASIS OF DESIGN

Reference codes, standards, and construction documents:

1.) 2020 Minnesota State Building Code (IBC 2018)
2.) ANSI/TIA-222-H, dated 2017, Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures.
3.) AISC 360-16, Specification for Structural Steel Buildings
4.) Design 1 / MIN Airport L-Sub 6 / Project No. 20202204430 / Rev. A drawings, dated 03/25/21.
5.) Design 1 / MIN Airport OPTM / Project No. 20192005319 / Rev. C drawings, dated 10/18/19.
6.) Design 1 / MINC Airport LTE ADD 850 / Project No. 20161458968 Rev A dwgs., dated 09/20/16.
7.) Design 1 / MINC Airport PCS-LTE / Project No. 20141138775 Rev. A dwgs, dated 01/22/15.
8.) Design 1 / MIN Airport / Project No. 01066304554 Rev 4 dwgs, dated 10/26/04.
9.) Herzog Engineering / MIN Airport OPTM / Project No. 191237 / Structural Review letter dated 10/21/19.
10.) Herzog Engineering / MIN Airport LTE ADD 850 / Project No. 161147 / Structural Review letter dated 01/25/17.

C. APPURTENANCES AND EQUIPMENT

**Table 1 - Proposed Antenna / Equipment**

| Equip. Owner | Centerline Elevation AGL (ft.) | Type | Pos. | QTY (per Sector) | Manuf. | Model | Status |
|---|---|---|---|---|---|---|---|
| **X, Y, and Z Sectors** | | | | | | | |
| Verizon | 139.0 | Antenna | 1 | 1 | CSS | X7C-CAP-86-865V | Exist. to Remain |
| | 137.8 | Dist. Box | 1.1[2] | 1 | Raycap | RVZDC-6627-PF-48 | |
| | 139.0 | Antenna | 2 | 1 | Ericsson | AIR 6449 | New |
| | 139.0 | Antenna | 3 | 1 | Commscope | NHH-45C-R2B | Exist. to Remain |
| | 133.0 | Radio | | 1 | Ericsson | 4449 | |
| | 142.3 | Antenna | 4 | 1 | Commscope | KRE 101 2251 | |
| | 133.0 | Radio | | 1 | Ericsson | RRUS32 | |
| | 137.8 | Dist. Box | 4.1[3] | 1 | Raycap | RVZDC-6627-PF-48 | |
| | 139.0 | Antenna | 5 | 1 | Commscope | NHH-45C-R2B | |
| | 133.0 | Radio | | 1 | Ericsson | RRUS32 | |
| **4th Sector** | | | | | | | |
| Verizon | 139.0 | Antenna | 1 | 1 | Commscope | NHH-45C-R2B | Exist. to Remain |
| | 132.3 | Radio | | 1 | Ericsson | RRUS 32 | |
| | 129.0 | Radio | | 1 | Ericsson | 4449 | |
| | 142.3 | Antenna | 2 | 1 | Ericsson | KRE 101 2251 | |
| | 131.3 | Radio | | 1 | Ericsson | RRUS 32 | |
| | 139.0 | Antenna | 3 | 1 | Commscope | NHH-45C-R2B | |
| | 137.3 | Dist. Box | | 1 | Raycap | RVZDC-6627-PF-48 | |

Table 1 Notes:

1.) The roof level of the existing building is 127.0' AGL.
2.) The Distribution Box at Position 1.1 only occurs at Sector X and is mounted on the interior side of the screen.
3.) The Distribution Box at Position 4.1 only occurs at Sectors Y and Z.

## D. RESULTS SUMMARY

**Table 2 - Mount Frame Member Design Check**

| Mount Member | Member Type | Max. Design Utilization | Pass / Fail | Remarks |
|---|---|---|---|---|
| **Typical XYZ Sectors** | | | | |
| Frame | Horizontal | **40%** | **Pass** | HSS3x3x3/16 |
| | Vertical | **42%** | **Pass** | HSS3x3x3/16 |
| | Mounting Pipe | **47%** | **Pass** | 2 1/2" Ø Sch. 40 Pipe |
| **4th Sector [3]** | | | | |
| Frame | Mounting Pipe | **63%** | **Pass** | 2 1/2" Ø Sch. 40 Pipe |

Table 2 Notes:

1. Maximum design utilization ratio is 100%, although design utilization ratios may be allowed up to 105% per the discretion of the professional engineer in charge of the mount design review.
2. See Appendix 1 for supporting structural calculations.
3. Although the 4th Sector has no new proposed loading, the configuration of the radios on the controlling mount is different from that previously proposed, therefore the updated controlling mount is reported in Appendix 1.

## E. REPORT DISCLAIMERS AND ASSUMPTIONS

1.) This report and analysis was performed under the assumption that all information provided to Herzog Engineering, LLC is current and correct. This includes but is not limited to site data, mapping reports, existing and proposed appurtenances, tower and foundation details, and geotechnical data. If this information is not current and correct, this report should be considered obsolete and further analysis will be required.

2.) This analysis assumes that the structural components and mounts, including all steel sections and attachment hardware are in good working order and in their original state, free from rust or other forms of corrosion.

3.) Capacity of the structural members is based on the member sizes and configuration supplied. The material grade is as per the data supplied or as assumed and stated.

4.) All connections (bolted and welded) are assumed to develop the member capacity unless stated otherwise in this report.

5.) Ring clamps and other clamp connections are excluded from this report and analysis unless noted otherwise in the report.

6.) This structural analysis and report by Herzog Engineering, LLC reviews only the main structural components of the mount. Unless noted otherwise, sub-elements such as bolts, welds, plate connections, etc. have been excluded from this analysis and report.

## F. APPENDIX 1 – STRUCTURAL CALCULATIONS

1.) Load Determination
2.) RISA-3D Frame Analysis (Controlling XYZ Sector Mount)
3.) RISA-3D Frame Analysis (Controlling 4th Sector Mount)

CASE #PL2021-208

HERZOG ENGINEERING LLC

Project: MIN Airport L-Sub 6
Project No. 211095
Date: 3/24/21
By: JTK

## Wind Load

Bloomington, MN

**Wind Load Design Criteria** — **TIA-222-H / Standard Reference**

| | | | |
|---|---|---|---|
| z = | 139 | feet | (Height above ground) |
| V = | 109 | MPH | (Basic wind speed without ice, ASCE 7-16 Hazard Tool) |
| Exposure Category = | C | | (A.2.6.5, and 2.6.5.1.2) |
| Risk Category = | II | | (A.2.2 and Table 2-1) |
| $K_d$ = | 0.95 | | (Table 2-2, also Kd=0.95 for all mounts per 16.6) |
| $Z_g$ = | 900 | | (Table 2-4) |
| $\alpha$ = | 9.50 | | (Table 2-4) |
| $K_{zmin}$ = | 0.85 | | (Table 2-4) |
| $K_c$ = | 1.00 | | (Table 2-4) |
| $2.01(z/z_g)^{2/\alpha}$ = | 1.36 | | (2.6.5.2) |
| $K_z$ = | 1.36 | | (2.6.5.2) |
| $K_{zt}$ = | 1.00 | | (2.6.6.2 Topographic Factor) |
| $G_h$ = | 1.00 | | (2.6.11.2 and 2.6.11, for appurtenance mounting systems Gh=1.0 per 16.6) |

Does the building meet the requirements of 1 or 2 under section 2.6.7? (Y or N) y

| | | |
|---|---|---|
| $z_p$ = | 3.00 | (Parapet height) |
| $z_r$ = | 16.00 | (Height above roof) |
| $X_b$ = | 45.00 | (Horiz. distance from windward face to center of structure) |
| $W_s$ = | 315.00 | (Width of the windward face of the building) |
| $H_s$ = | 128.00 | (Height of the windward face of the building) |
| $H_1$ = | 12.00 | |
| $H_2$ = | 131.00 | |
| Is $H_1 <= z_r <= H_2$? | YES | |
| $W_s/H_s$ | 1.00 | |
| $K_s$ = | 1.30 | (2.6.7 and Fig. 2-2) |
| $K_a$ = | 0.90 | (2.6.11.2-for Mounting systems, Ka=0.90 per 16.6) |
| $K_e$ = | 1.00 | (2.6.8) |
| $q_z$ = | 50.95 psf | (2.6.11.6 Velocity Pressure) |
| $C_{a(flat)}$ = | 2.00 | (Table 2-9) |
| $C_{a(round)}$ = | 1.20 | (Table 2-9) |

**Wind Loads**

**Any Flat Surface** 91.72 psf

**Angles**

| | Leg (in.) | $A_A$ | $EPA_A$ | $F_{A(wind)}$ (lb/ft) |
|---|---|---|---|---|
| L5x5 | 5 | 0.42 | 0.75 | 38.21 |

**Pipe Rounds**

| | OD (in.) | $A_A$ | $EPA_A$ | $F_{A(wind)}$ (lb/ft) |
|---|---|---|---|---|
| Pipe 2 1/2 Std. | 2.88 | 0.24 | 0.26 | 13.21 |

**HSS**

| | Height (in.) | Thickness (in.) | OSC Radius (in.) | rs | $C_{a(HSS)}$ | $A_A$ | $EPA_A$ | $F_{A(wind)}$ (lb/ft) |
|---|---|---|---|---|---|---|---|---|
| HSS3x3x3/16 | 3.00 | 0.188 | 0.422 | 0.141 | 1.25 | 0.25 | 0.28 | 14.33 |

HERZOG ENGINEERING LLC

Project: MIN Airport L-Sub 6
Project No. 211095
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By: JTK

## Wind Load (Continued)

### Wind Loads

**Cold Formed Steel Channels**

| | Leg (in.) | $A_A$ | $EPA_A$ | $F_{A(wind)}$ (lb/ft) |
|---|---|---|---|---|
| P1000 Unistrut | 1.63 | 0.14 | 0.24 | 12.42 |

**Equipment**

| | Width (in.) | Length (in.) | Height (in.) | $A_A$ (sq. ft.) | $C_A$ | $EPA_A$ (sq. ft.) | $F_{A(wind)}$ (lbs.) | Weight (lbs.) |
|---|---|---|---|---|---|---|---|---|
| **NORMAL** | | | | | | | | |
| KRE 101 2251 Antenna | 7.9 | 4.7 | 17.7 | 1.0 | 1.2 | 1.0 | 53.3 | 33.0 |
| X7CQAP-86-865-V Antenna | 14.6 | 7.3 | 96.0 | 9.7 | 1.4 | 12.1 | 616.5 | 71.8 |
| NHH-45C-R2B Antenna | 18.0 | 7.0 | 95.9 | 12.0 | 1.3 | 14.3 | 728.8 | 87.1 |
| Air 6449 Antenna | 15.9 | 10.6 | 30.6 | 3.4 | 1.2 | 3.6 | 185.9 | 96.8 |
| RRUS32 Radio | 12.1 | 7.0 | 27.2 | 2.3 | 1.2 | 2.5 | 125.8 | 52.9 |
| 4449 Radio | 13.2 | 9.4 | 18.0 | 1.7 | 1.2 | 1.8 | 90.8 | 70.0 |
| 6627 Distribution Box | 16.5 | 12.6 | 29.5 | 3.4 | 1.2 | 3.7 | 186.0 | 32.0 |
| Splice Box | 14.0 | 4.0 | 14.0 | 1.4 | 1.2 | 1.5 | 74.9 | 5.0 |
| **TRANSVERSE** | | | | | | | | |
| KRE 101 2251 Antenna | 4.7 | 7.9 | 17.7 | 0.6 | 1.3 | 0.7 | 33.3 | |
| X7CQAP-86-865-V Antenna | 7.3 | 14.6 | 96.0 | 4.9 | 1.6 | 7.0 | 358.2 | |
| NHH-45C-R2B Antenna | 7.0 | 18.0 | 95.9 | 4.7 | 1.6 | 6.8 | 347.0 | |
| Air 6449 Antenna | 10.6 | 15.9 | 30.6 | 2.3 | 1.2 | 2.5 | 125.7 | |
| RRUS32 Radio | 7.0 | 12.1 | 27.2 | 1.3 | 1.3 | 1.5 | 76.5 | |
| 4449 Radio | 9.4 | 13.2 | 18.0 | 1.2 | 1.2 | 1.3 | 64.7 | |
| 6627 Distribution Box | 12.6 | 16.5 | 29.5 | 2.6 | 1.2 | 2.8 | 142.0 | |
| Splice Box | 4.0 | 14.0 | 14.0 | 0.4 | 1.2 | 0.4 | 22.2 | |

HERZOG ENGINEERING LLC

Project: MIN Airport L-Sub 6
Project No. 211095
Date: 3/24/21
By: JTK

## Ice Load

**Ice Load Design Criteria** — **TIA-222-H / Standard Reference**

| | | | |
|---|---|---|---|
| $z$ = | **139** | **feet** | (Height above ground) |
| $t_i$ = | **1.50** | **inches** | (Design ice thickness for site location - Fig. B-9, ASCE 7-16 Hazard Tool) |
| Risk Category = | **II** | | |
| $I_{ice}$ = | **1.00** | | (Table 2-3) |
| $K_{iz}$ = | **1.15** | | (2.6.10 Height Escalation Factor) |
| $K_{zt}$ = | **1.00** | | (2.6.6.2 Topographic Factor) |
| $t_{iz}$ = | **1.73** | **inches** | (Design ice thickness for site location, 2.6.10) |
| $\gamma_{ice}$ = | **56.00** | lb/ft$^3$ | (2.6.10 Unit weight of ice) |

**Ice Loads**

**Angles**

| | | $D_c$ | $A_{iz}$ | $w_{ice}$ (lb/ft) |
|---|---|---|---|---|
| L5x5 | 5 | 7.07 | 47.90 | 18.63 |

**Pipe Rounds**

| | | $D_c$ | $A_{iz}$ | $w_{ice}$ (lb/ft) |
|---|---|---|---|---|
| Pipe 2 1/2 Std. | 2.88 | 2.88 | 25.09 | 9.76 |

**HSS**

| | Height (in.) | Width (in.) | $D_c$ | $A_{iz}$ | $w_{ice}$ (lb/ft) |
|---|---|---|---|---|---|
| HSS3x3 | 3.0 | 3.0 | 4.24 | 32.51 | 12.64 |

**Cold Formed Steel Channels**

| | Web (in.) | Flange (in.) | $D_c$ | $A_{iz}$ | $w_{ice}$ (lb/ft) |
|---|---|---|---|---|---|
| P1000 Unistrut | 1.63 | 1.625 | 2.30 | 21.93 | 8.53 |

**Equipment**

| | Width (in.) | Length (in.) | Height (in.) | $D_c$ (in.) | $A_{iz}$ (sq. in.) | $w_{ice}$ (lb/ft) | $W_{ice}$ (lbs.) |
|---|---|---|---|---|---|---|---|
| KRE 101 2251 Antenna | 7.88 | 4.7 | 17.7 | 9.2 | 59.3 | 23.1 | 34.0 |
| X7CQAP-86-865-V Antenna | 14.6 | 7.3 | 96 | 16.3 | 98.2 | 38.2 | 305.6 |
| NHH-45C-R2B Antenna | 18 | 7 | 95.9 | 19.3 | 114.5 | 44.5 | 355.9 |
| Air 6449 Antenna | 15.9 | 10.6 | 30.6 | 19.1 | 113.4 | 44.1 | 112.5 |
| RRUS32 Radio | 12.1 | 7 | 27.2 | 14.0 | 85.5 | 33.2 | 75.4 |
| 4449 Radio | 13.2 | 9.4 | 18 | 16.2 | 97.6 | 38.0 | 56.9 |
| 6627 Distribution Box | 16.5 | 12.6 | 29.5 | 20.8 | 122.4 | 47.6 | 117.0 |
| Splice Box | 14 | 4 | 14 | 14.6 | 88.6 | 34.5 | 40.2 |

HERZOG ENGINEERING LLC

Project: MIN Airport L-Sub 6
Project No. 211095
Date: 3/24/21
By: JTK

## Wind Load on Ice

**Wind Load on Ice Design Criteria** — **TIA-222-H / Standard Reference**

| | | | |
|---|---|---|---|
| $z$ = | **139** | **feet** | (Height above ground) |
| $V_i$ = | **50** | **MPH** | (Basic wind speed with ice, Fig. B-9) |
| $t_{iz}$ = | **1.73** | **inches** | (Design ice thickness for site location, 2.6.10) |
| $K_d$ = | **0.95** | | (Table 2-2, also Kd=0.95 for all mounts per 16.6) |
| $K_z$ = | **1.36** | | (2.6.5.2) |
| $K_{zt}$ = | **1.00** | | (2.6.6.2 Topographic Factor) |
| $G_h$ = | **1.00** | | (2.6.11.2 and 2.6.11, for appurtenance mounting systems Gh=1.0 per 16.6) |
| $K_s$ = | **1.30** | | (2.6.7 and Fig. 2-2) |
| $K_a$ = | **0.90** | | (2.6.11.2-for Mounting systems, Ka=0.90 per 16.6) |
| $K_e$ = | **1.00** | | (2.6.8) |
| $q_{zice}$ = | **8.25** | **psf** | (2.6.9.6 Velocity Pressure with ice) |
| $C_{a(flat)}$ = | **2.00** | | (Table 2-9) |
| $C_{a(round)}$ = | **1.20** | | (Table 2-9) |

**Wind Loads on Ice**

**Angles**

| | Leg (in.) | $A_A$ | $EPA_A$ | $F_{A(windonice)}$ (lb/ft) |
|---|---|---|---|---|
| L5x5 | 5 | 0.71 | 0.76 | 6.28 |

**Pipe Rounds**

| | OD (in.) | $A_{aice}$ | $EPA_{Aice}$ | $F_{A(windonice)}$ (lb/ft) |
|---|---|---|---|---|
| Pipe 2 1/2 Std. | 2.88 | 0.53 | 0.57 | 4.71 |

**HSS**

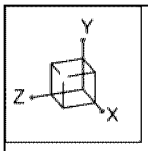
| | Height (in.) | $A_A$ | $EPA_A$ | $F_{A(windonice)}$ (lb/ft) |
|---|---|---|---|---|
| HSS3x3 | 3.00 | 0.54 | 0.58 | 4.80 |

**Cold Formed Steel Channels**

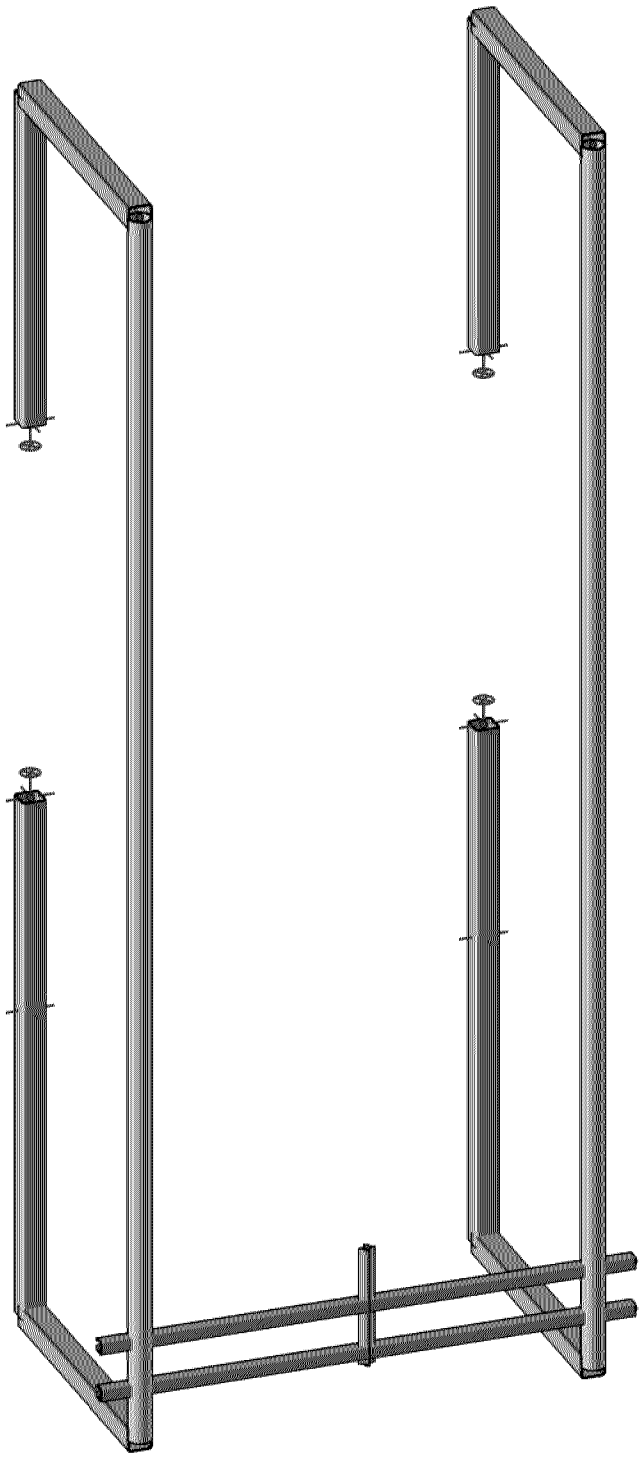
| | Leg (in.) | $A_A$ | $EPA_A$ | $F_{A(windonice)}$ (lb/ft) |
|---|---|---|---|---|
| P1000 Unistrut | 1.63 | 0.42 | 0.46 | 3.78 |

**Equipment**

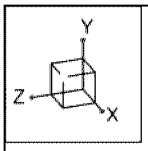
| | Width (in.) | Length (in.) | Height (in.) | $A_{iz}$ (sq. in.) | Eff. Dia w/ Ice (in.) | $EPA_{Aice}$ (sq. ft.) | $F_{A(windonice)}$ (lbs.) |
|---|---|---|---|---|---|---|---|
| KRE 101 2251 Antenna | 7.88 | 4.7 | 17.7 | 59.3 | 12.6 | 1.7 | 13.8 |
| X7CQAP-86-865-V Antenna | 14.6 | 7.3 | 96 | 98.2 | 19.8 | 14.2 | 117.5 |
| NHH-45C-R2B Antenna | 18 | 7 | 95.9 | 114.5 | 22.8 | 16.4 | 135.1 |
| Air 6449 Antenna | 15.9 | 10.6 | 30.6 | 113.4 | 22.6 | 5.2 | 42.7 |
| RRUS32 Radio | 12.1 | 7 | 27.2 | 85.5 | 17.4 | 3.6 | 29.3 |
| 4449 Radio | 13.2 | 9.4 | 18 | 97.6 | 19.7 | 2.7 | 21.9 |
| 6627 Distribution Box | 16.5 | 12.6 | 29.5 | 122.4 | 24.2 | 5.4 | 44.2 |
| Splice Box | 14 | 4 | 14 | 88.6 | 18.0 | 1.9 | 15.6 |

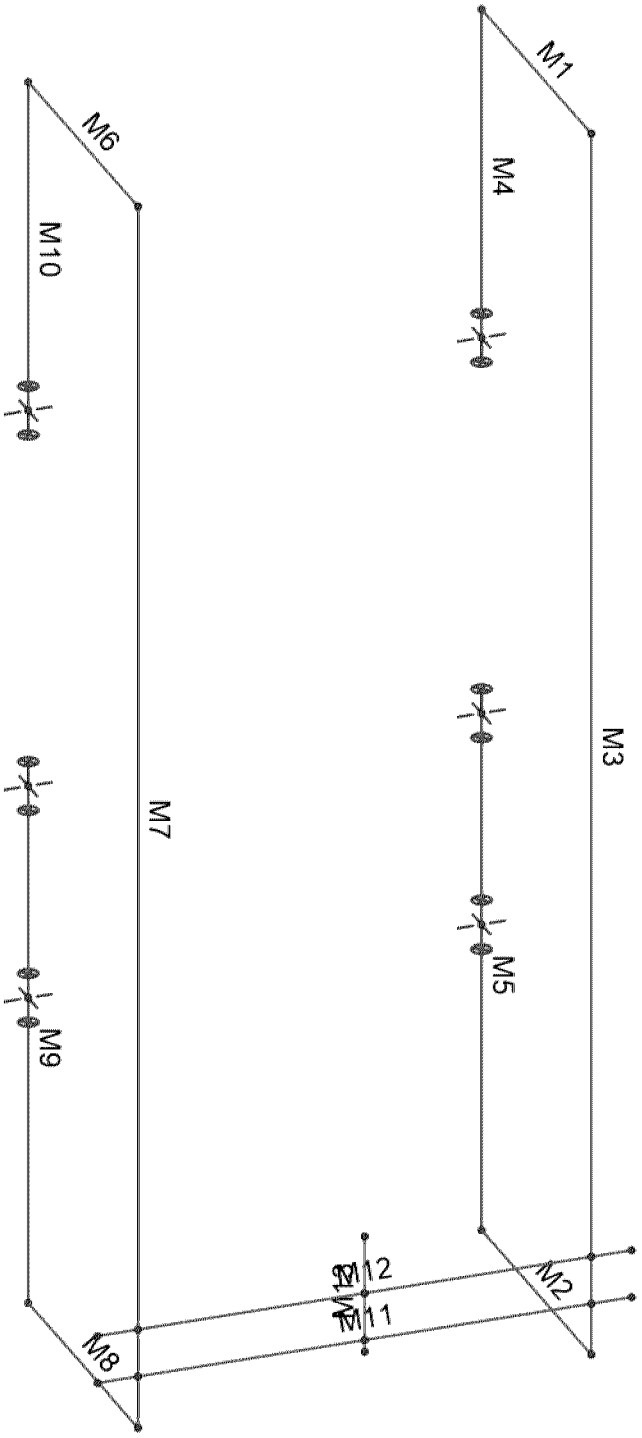



# XYZ Sectors Controlling Mount

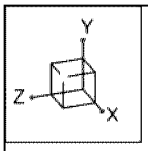


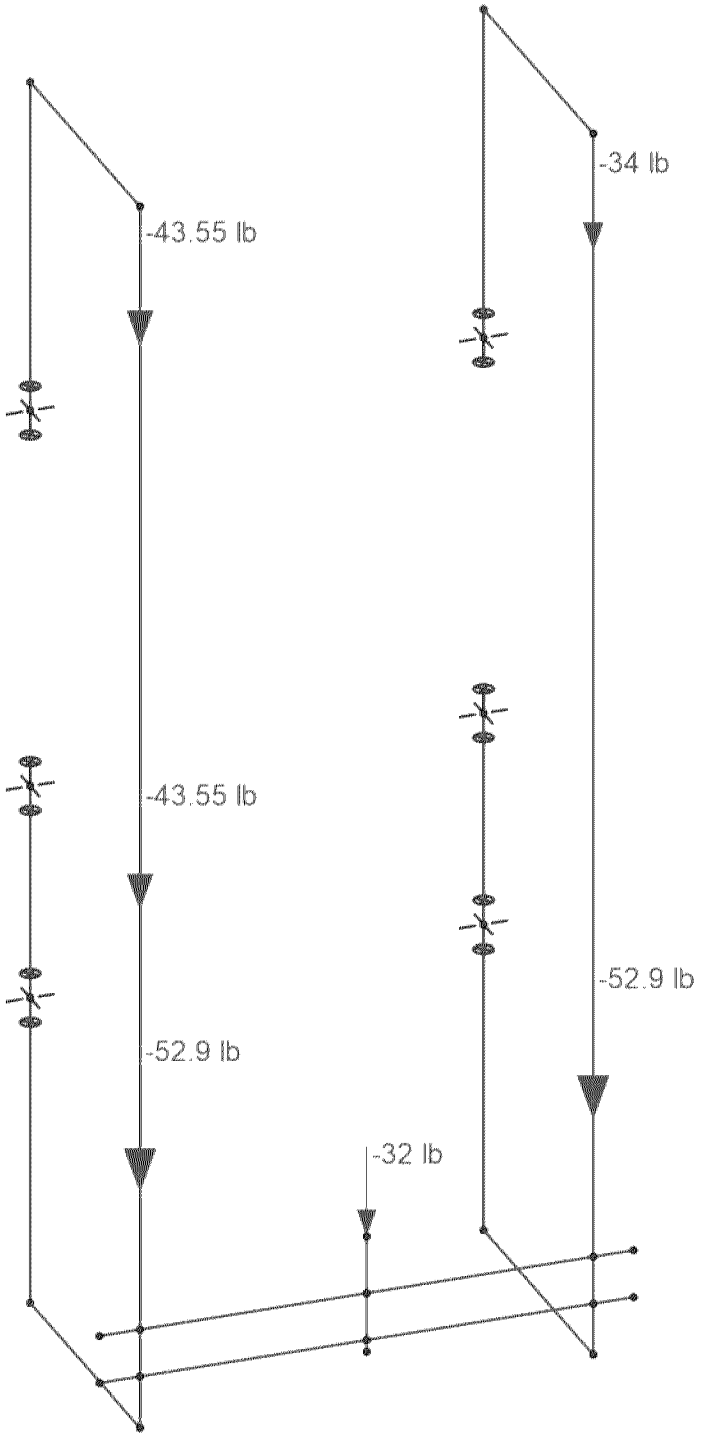
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Rendered Isometric 1 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |



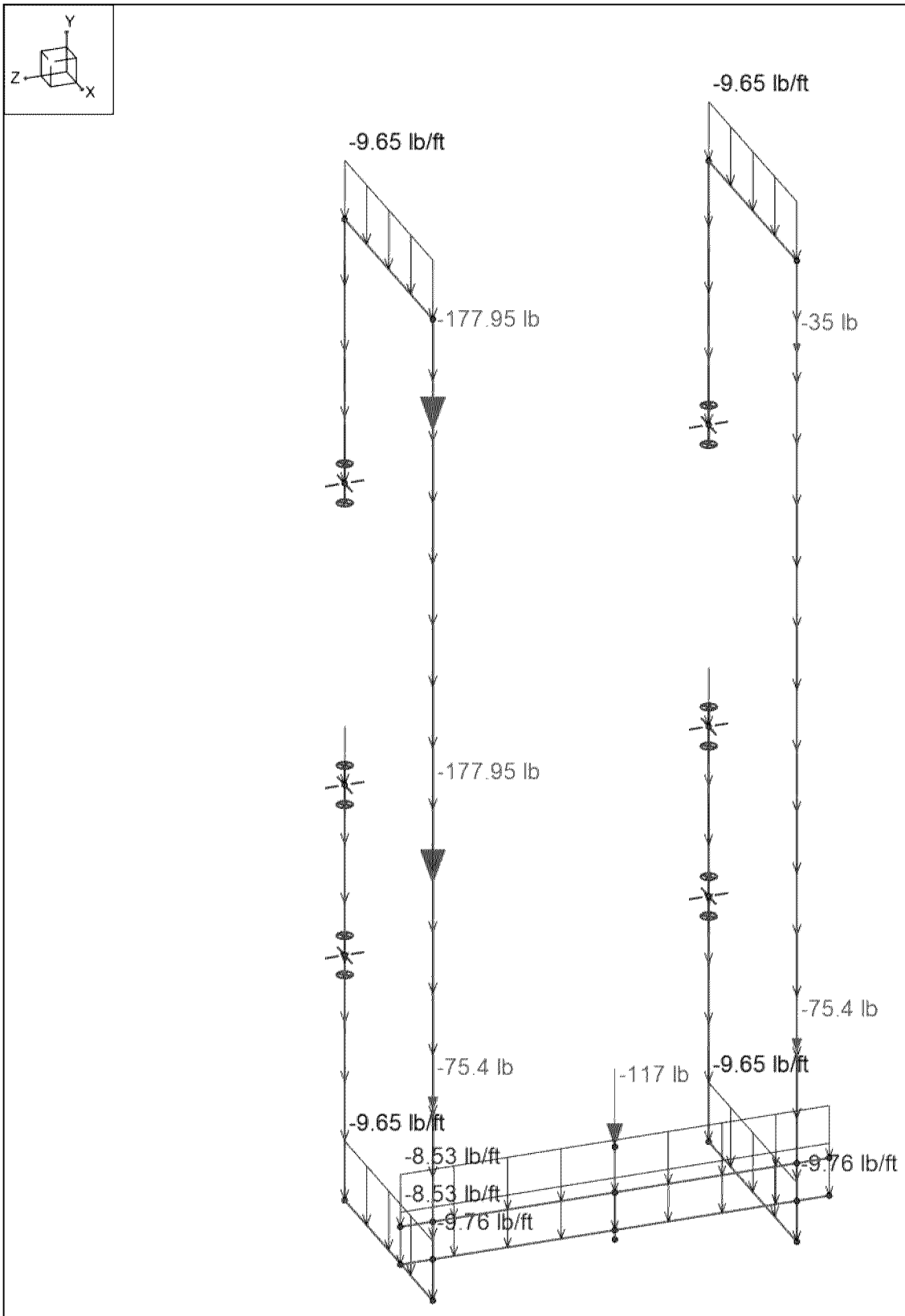

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Member Labels 2 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |



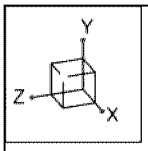

Loads: BLC 2, DL Equipment

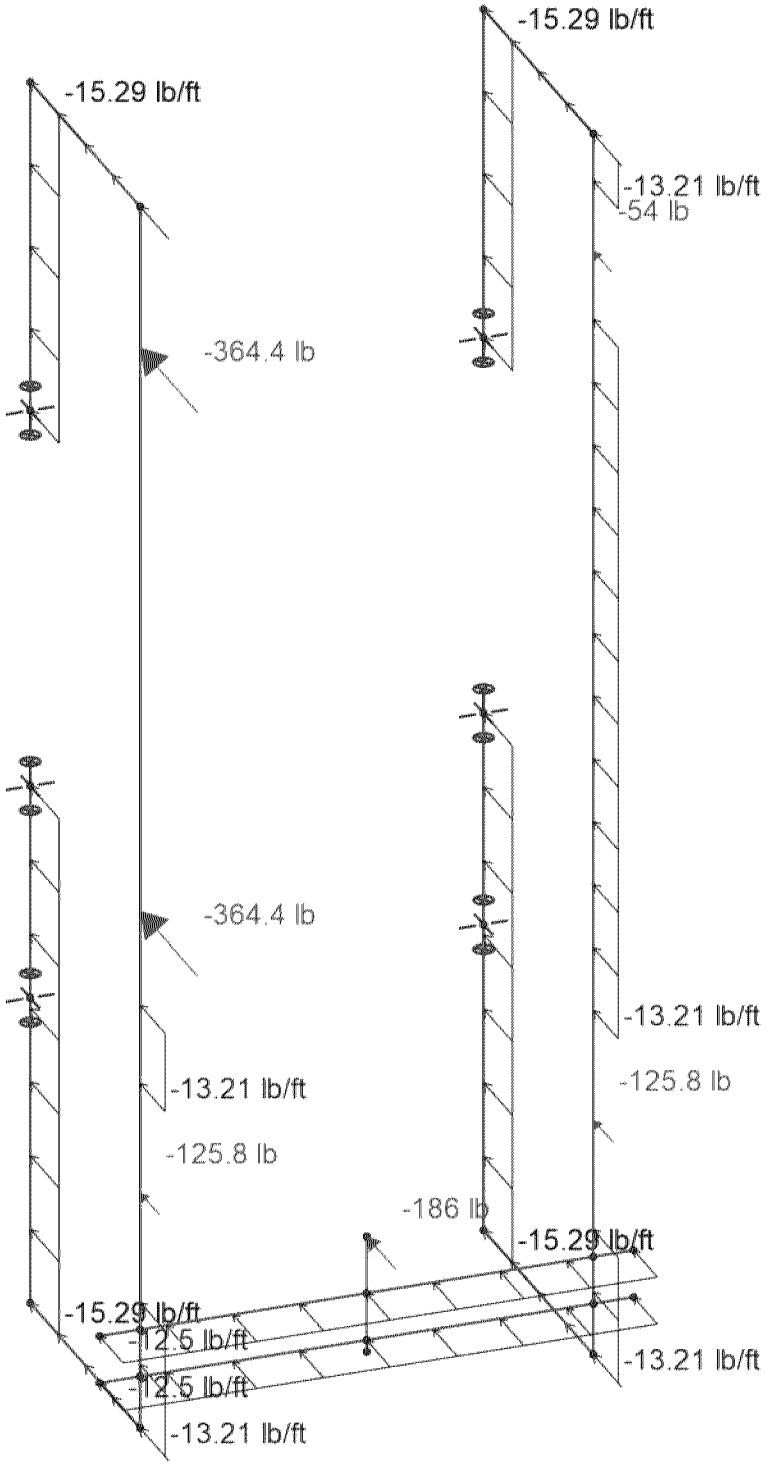
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Equipment DL 3 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |




Loads: BLC 3, Ice Load

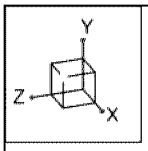
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Ice Load 4 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |

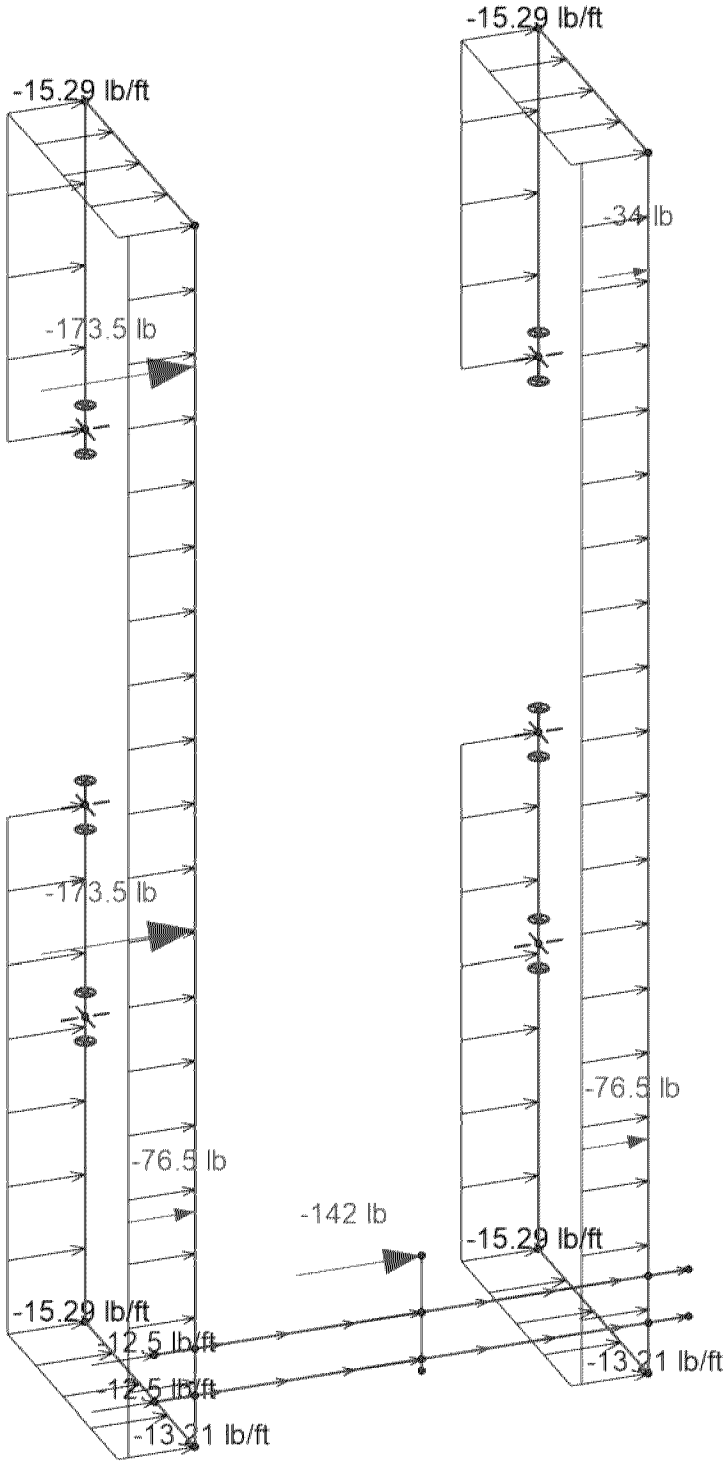



Loads: BLC 4, WLx

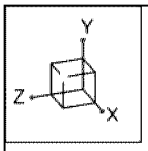
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Wind Load (+x) 5 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |

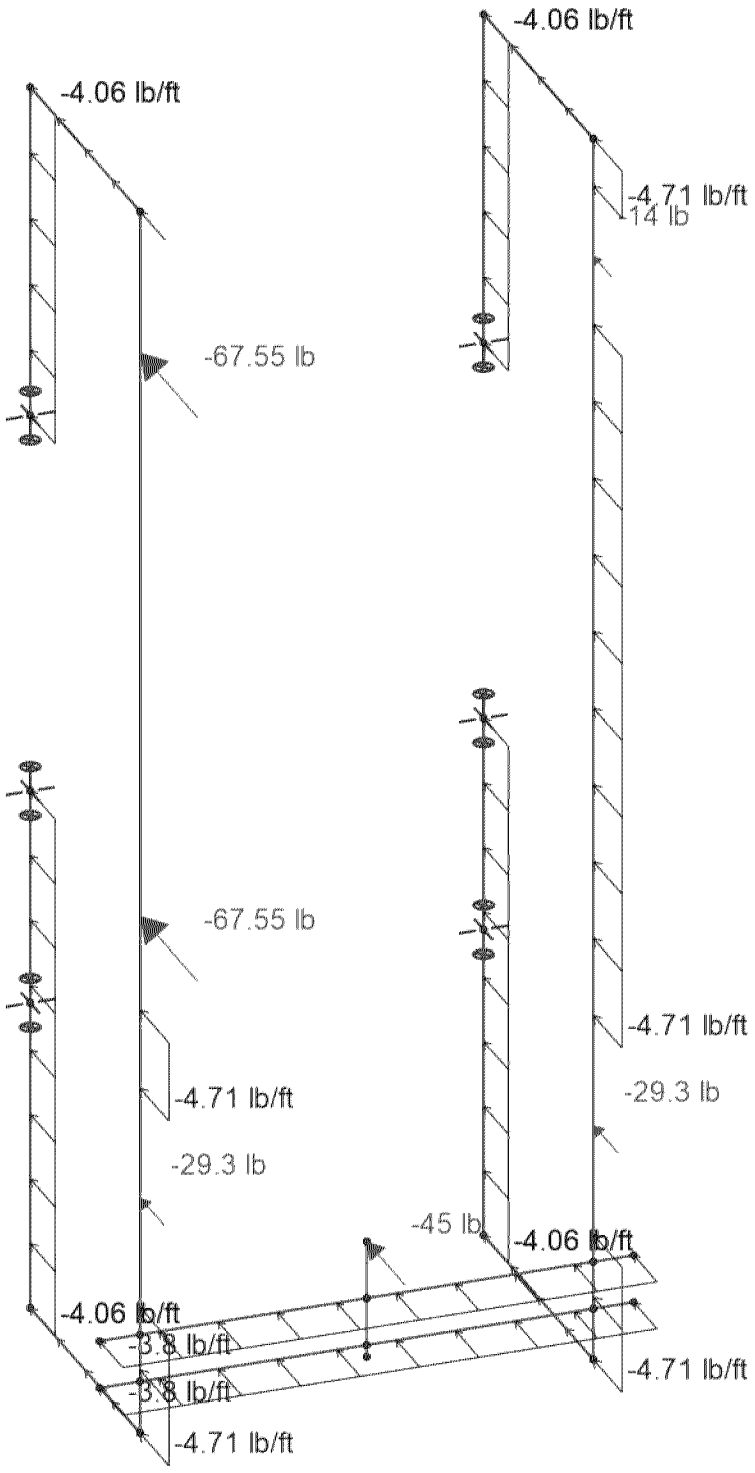



Loads: BLC 5, WLz

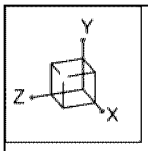
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Wind Load (+z) 6 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |

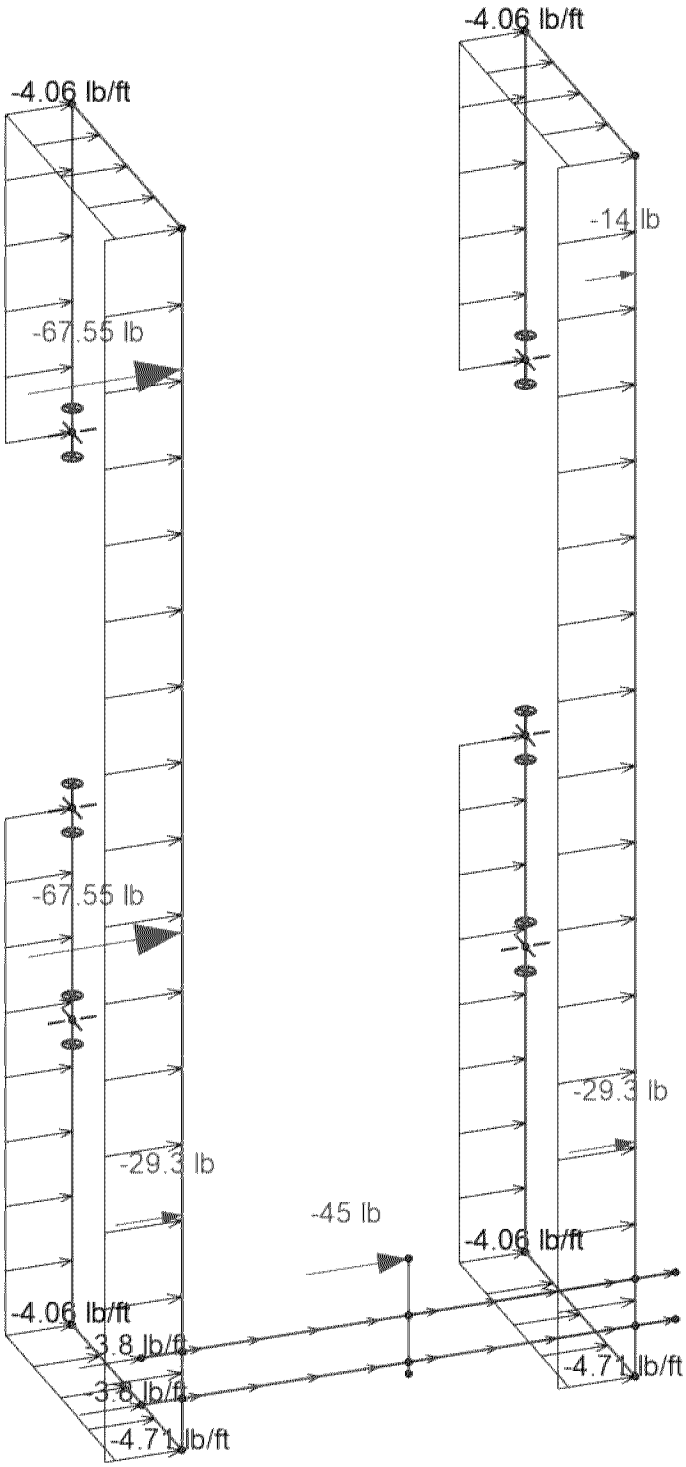



Loads: BLC 6, WLx on Ice

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Wind Load on Ice (+x) 7 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |




Loads: BLC 7, WLz on Ice

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 (controlling location) | Wind Load on Ice (+z) 8 |
| JTK | | Mar 24, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - Cont… |

### Hot Rolled Steel Properties

| | Label | E [ksi] | G [ksi] | Nu | Therm. Coeff. [1e5°F⁻¹] | Density [k/ft³] | Yield [ksi] | Ry | Fu [ksi] | Rt |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A992 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.1 | 65 | 1.1 |
| 2 | A36 Gr.36 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 36 | 1.5 | 58 | 1.2 |
| 3 | A572 Gr.50 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.1 | 65 | 1.1 |
| 4 | A500 Gr.B RND | 29000 | 11154 | 0.3 | 0.65 | 0.527 | 42 | 1.4 | 58 | 1.3 |
| 5 | A500 Gr.B Rect | 29000 | 11154 | 0.3 | 0.65 | 0.527 | 46 | 1.4 | 58 | 1.3 |
| 6 | A53 Gr.B | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 35 | 1.6 | 60 | 1.2 |
| 7 | A1085 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.4 | 65 | 1.3 |

### Hot Rolled Steel Section Sets

| | Label | Shape | Type | Design List | Material | Design Rule | Area [in²] | Iyy [in⁴] | Izz [in⁴] | J [in⁴] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | mounting pipe | PIPE_2.5 | Column | Pipe | A53 Gr.B | Typical | 1.61 | 1.45 | 1.45 | 2.89 |
| 2 | HSS frame vert | HSS3X3X3 | Column | SquareTube | A500 Gr.B Rect | Typical | 1.89 | 2.46 | 2.46 | 4.03 |
| 3 | HSS frame horiz | HSS3X3X3 | Beam | SquareTube | A500 Gr.B Rect | Typical | 1.89 | 2.46 | 2.46 | 4.03 |

### Member Primary Data

| | Label | I Node | J Node | Rotate(deg) | Section/Shape | Type | Design List | Material | Design Rule |
|---|---|---|---|---|---|---|---|---|---|
| 1 | M1 | N4 | N2 | | HSS frame horiz | Beam | SquareTube | A500 Gr.B Rect | Typical |
| 2 | M2 | N3 | N1 | | HSS frame horiz | Beam | SquareTube | A500 Gr.B Rect | Typical |
| 3 | M3 | N1 | N2 | | mounting pipe | Column | Pipe | A53 Gr.B | Typical |
| 4 | M4 | N4 | N5 | | HSS frame vert | Column | SquareTube | A500 Gr.B Rect | Typical |
| 5 | M5 | N3 | N6 | | HSS frame vert | Column | SquareTube | A500 Gr.B Rect | Typical |
| 6 | M6 | N11 | N9 | | HSS frame horiz | Beam | SquareTube | A500 Gr.B Rect | Typical |
| 7 | M7 | N8 | N9 | | mounting pipe | Column | Pipe | A53 Gr.B | Typical |
| 8 | M8 | N10 | N8 | | HSS frame horiz | Beam | SquareTube | A500 Gr.B Rect | Typical |
| 9 | M9 | N10 | N13 | | HSS frame vert | Column | SquareTube | A500 Gr.B Rect | Typical |
| 10 | M10 | N11 | N12 | | HSS frame vert | Column | SquareTube | A500 Gr.B Rect | Typical |
| 11 | M11 | N17 | N18 | 180 | Unistrut | Beam | CS | A653 SS Gr33 | Typical |
| 12 | M12 | N21 | N22 | 180 | Unistrut | Beam | CS | A653 SS Gr33 | Typical |
| 13 | M13 | N25 | N26 | | RIGID | None | None | RIGID | Typical |

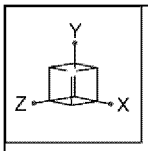
### Load Combinations

| | Description | Solve | PDelta | BLC | Factor | BLC | Factor | BLC | Factor | BLC | Factor | BLC | Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.4DL+1.4DLequip | Yes | Y | 1 | 1.4 | 2 | 1.4 | | | | | | |
| 2 | 1.2DL+1.2DLequip+1.0WL (0 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | 1 | | | | |
| 3 | 1.2DL+1.2DLequip+1.0WL (30 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | 0.87 | 5 | 0.5 | | |
| 4 | 1.2DL+1.2DLequip+1.0WL (60 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | 0.5 | 5 | 0.87 | | |
| 5 | 1.2DL+1.2DLequip+1.0WL (90 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 5 | 1 | | | | |
| 6 | 1.2DL+1.2DLequip+1.0WL (120 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | -0.5 | 5 | 0.87 | | |
| 7 | 1.2DL+1.2DLequip+1.0WL (150 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | -0.87 | 5 | 0.5 | | |
| 8 | 1.2DL+1.2DLequip+1.0WL (180 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | -1 | | | | |
| 9 | 1.2DL+1.2DLequip+1.0WL (210 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | -0.87 | 5 | -0.5 | | |
| 10 | 1.2DL+1.2DLequip+1.0WL (240 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | -0.5 | 5 | -0.87 | | |
| 11 | 1.2DL+1.2DLequip+1.0WL (270 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 5 | -1 | | | | |
| 12 | 1.2DL+1.2DLequip+1.0WL (300 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | 0.5 | 5 | -0.87 | | |
| 13 | 1.2DL+1.2DLequip+1.0WL (330 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 4 | 0.87 | 5 | -0.5 | | |
| 14 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (0 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | 1 | | |
| 15 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (30 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | 0.87 | 7 | 0.5 |
| 16 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (60 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | 0.5 | 7 | 0.87 |
| 17 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (90 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 7 | 1 | | |
| 18 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (120 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | -0.5 | 7 | 0.87 |
| 19 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (150 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | -0.87 | 7 | 0.5 |
| 20 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (180 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | -1 | | |
| 21 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (210 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | -0.87 | 7 | -0.5 |
| 22 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (240 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | -0.5 | 7 | -0.87 |
| 23 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (270 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 7 | -1 | | |
| 24 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (300 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | 0.5 | 7 | -0.87 |
| 25 | 1.2DL+1.2DLequip+1.0Ice+1.0WLice (330 deg) | Yes | Y | 1 | 1.2 | 2 | 1.2 | 3 | 1 | 6 | 0.87 | 7 | -0.5 |

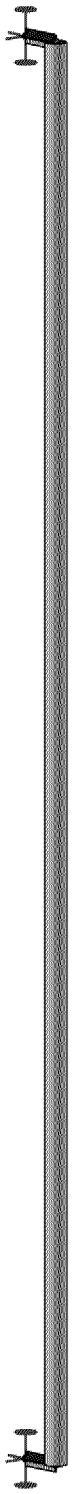
***Envelope AISC 15TH (360-16): LRFD Member Steel Code Checks***

| | Member | Shape | Code Check | Loc[in] | LC | Shear Check | Loc[in] | Dir | LC | phi*Pnc [lb] | phi*Pnt [lb] | phi*Mn y-y [k-ft] | phi*Mn z-z [k-ft] | Cb | Eqn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M1 | HSS3X3X3 | 0.175 | 0 | 7 | 0.172 | 0 | z | 11 | 73176.811 | 78246 | 6.796 | 6.796 | 1.102 | H1-1b |
| 2 | M2 | HSS3X3X3 | 0.234 | 0 | 7 | 0.108 | 0 | z | 11 | 73176.811 | 78246 | 6.796 | 6.796 | 1.85 | H1-1b |
| 3 | M3 | PIPE_2.5 | 0.273 | 156 | 5 | 0.16 | 6.5 | | 4 | 13460.421 | 50715 | 3.596 | 3.596 | 2.648 | H1-1b |
| 4 | M4 | HSS3X3X3 | 0.201 | 0 | 6 | 0.119 | 42 | z | 11 | 71428.123 | 78246 | 6.796 | 6.796 | 1.631 | H1-1b |
| 5 | M5 | HSS3X3X3 | 0.303 | 38.5 | 17 | 0.135 | 38.5 | z | 5 | 62472.935 | 78246 | 6.796 | 6.796 | 1.185 | H1-1b |
| 6 | M6 | HSS3X3X3 | 0.405 | 0 | 10 | 0.299 | 0 | z | 11 | 73176.811 | 78246 | 6.796 | 6.796 | 1.127 | H3-6 |
| 7 | M7 | PIPE_2.5 | 0.468 | 156 | 10 | 0.125 | 6.5 | | 6 | 13460.421 | 50715 | 3.596 | 3.596 | 2.146 | H1-1b |
| 8 | M8 | HSS3X3X3 | 0.315 | 0 | 7 | 0.109 | 0 | y | 11 | 73176.811 | 78246 | 6.796 | 6.796 | 1.436 | H1-1b |
| 9 | M9 | HSS3X3X3 | 0.314 | 38.5 | 24 | 0.136 | 38.5 | z | 11 | 62472.935 | 78246 | 6.796 | 6.796 | 1.193 | H1-1b |
| 10 | M10 | HSS3X3X3 | 0.425 | 0 | 9 | 0.209 | 42 | z | 11 | 71428.123 | 78246 | 6.796 | 6.796 | 1.648 | H1-1b |

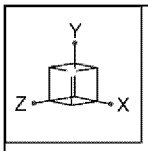
CASE #PL2021-208

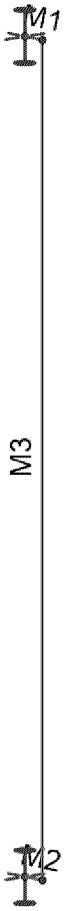



# 4th Sector Controlling Mount

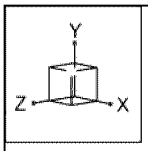


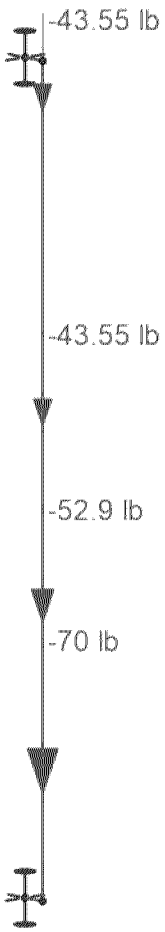
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | Rendered Isometric 1 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |



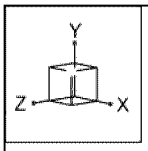

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | Member Labels 2 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

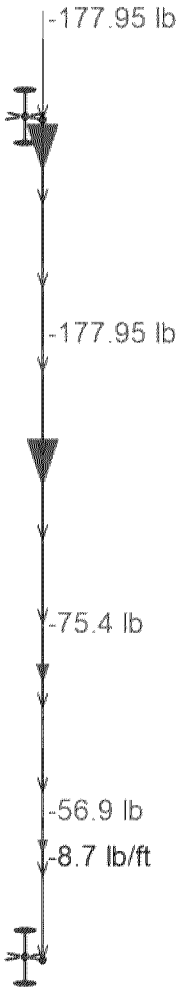



Loads: BLC 2, DL Equipment

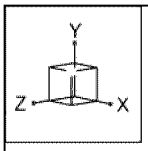
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | Dead Load 3 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

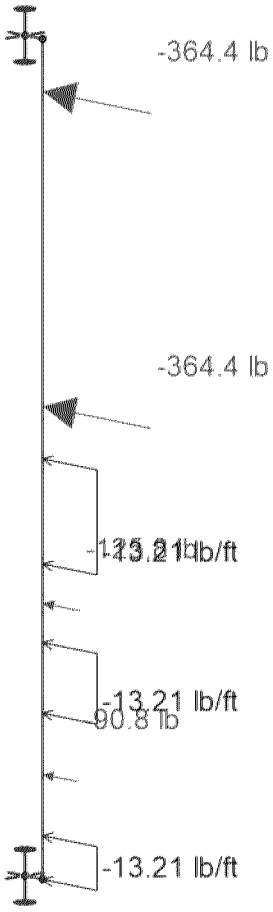



Loads: BLC 3, Ice Load

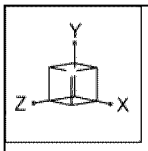
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | Ice Load 4 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

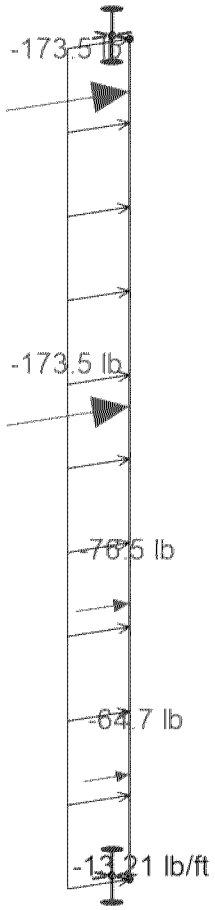



Loads: BLC 4, WLx

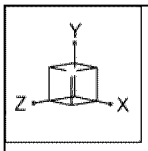
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | WInd Load (+x) 5 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

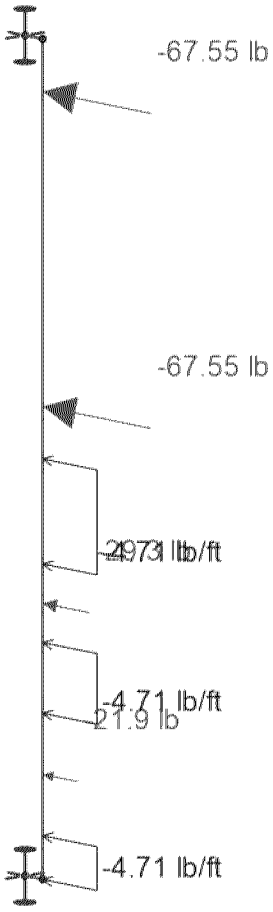



Loads: BLC 5, WLz

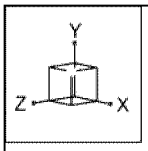
| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | WInd Load (+z) 6 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

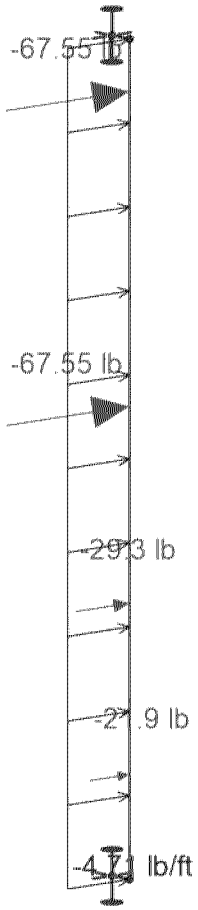



Loads: BLC 6, WLx on Ice

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | WInd Load on Ice (+x) 7 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |




Loads: BLC 7, WLz on Ice

| | | |
|---|---|---|
| Herzog Engineering, LLC | MIN Airport L-Sub 6 4th Sector Controlling Mount | Wind Load on Ice (+z) 8 |
| JTK | | Mar 25, 2021 |
| 211095 | | 211095 MIN Airport L-Sub 6 - 4th s… |

### Hot Rolled Steel Properties

| | Label | E [ksi] | G [ksi] | Nu | Therm. Coeff. [1e5°F⁻¹] | Density [k/ft³] | Yield [ksi] | Ry | Fu [ksi] | Rt |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A992 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.1 | 65 | 1.1 |
| 2 | A36 Gr.36 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 36 | 1.5 | 58 | 1.2 |
| 3 | A572 Gr.50 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.1 | 65 | 1.1 |
| 4 | A500 Gr.B RND | 29000 | 11154 | 0.3 | 0.65 | 0.527 | 42 | 1.4 | 58 | 1.3 |
| 5 | A500 Gr.B Rect | 29000 | 11154 | 0.3 | 0.65 | 0.527 | 46 | 1.4 | 58 | 1.3 |
| 6 | A53 Gr.B | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 35 | 1.6 | 60 | 1.2 |
| 7 | A1085 | 29000 | 11154 | 0.3 | 0.65 | 0.49 | 50 | 1.4 | 65 | 1.3 |

### Hot Rolled Steel Section Sets

| | Label | Shape | Type | Design List | Material | Design Rule | Area [in²] | Iyy [in⁴] | Izz [in⁴] | J [in⁴] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | mounting pipe | PIPE_2.5 | Column | Pipe | A53 Gr.B | Typical | 1.61 | 1.45 | 1.45 | 2.89 |
| 2 | HSS frame vert | HSS2X2X4 | Column | SquareTube | A500 Gr.B Rect | Typical | 1.51 | 0.747 | 0.747 | 1.31 |
| 3 | HSS frame horiz | HSS2X2X4 | Beam | SquareTube | A500 Gr.B Rect | Typical | 1.51 | 0.747 | 0.747 | 1.31 |

### Member Primary Data

| | Label | I Node | J Node | Section/Shape | Type | Design List | Material | Design Rule |
|---|---|---|---|---|---|---|---|---|
| 1 | M1 | N4 | N2 | RIGID | None | None | RIGID | Typical |
| 2 | M2 | N3 | N1 | RIGID | None | None | RIGID | Typical |
| 3 | M3 | N1 | N2 | mounting pipe | Column | Pipe | A53 Gr.B | Typical |

### Envelope AISC 15TH (360-16): LRFD Member Steel Code Checks

| | Member | Shape | Code Check | Loc[in] | LC | Shear Check | Loc[in] | LC | phi*Pnc [lb] | phi*Pnt [lb] | phi*Mn y-y [k-ft] | phi*Mn z-z [k-ft] | Cb | Eqn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M3 | PIPE_2.5 | 0.627 | 0 | 2 | 0.041 | 192 | 8 | 8885.981 | 50715 | 3.596 | 3.596 | 2.367 | H1-1a |